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(54) STEEL PLATE WITH EXCELLENT PAINTING DISTINCTNESS OF IMAGE AND PRESSING WORKABILITY

(57)Abstract:

PURPOSE: To provide a steel plate having an excellent distinctness of image even after pressing.

CONSTITUTION: In both inside and outside of a steel plate, a size of top surface of a scattered projecting part is 10-1000μm a distance between peaks of the projecting parts is 50-2200μm, a roughness R of a recessing part ≤0.8μm, and the projecting parts are discretely distributed so that an average area ratio of the recessing parts is made ≥70%, further the height of vertex of the projecting part scattered on both side of the steel plate is lain in a range 2-12μm, and the height of one side projecting part is made higher than the other side within the range 3-20μm.

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* NOTICES *

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2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1] The magnitude of a scattered heights top face in front flesh-side both sides of a steel plate 10-1000 micrometers, By 0.8 micrometers or less, the roughness Ra of 50-2200 micrometers and a crevice carries out [distance / between heights peaks] discrete distribution of the heights so that the rate of average area of a crevice may become 70% or more. And the steel plate which is in the range whose height of the heights top-most vertices which are scattered in a steel plate one side side is 2-12 micrometers, and was excellent in the paint image clarity characterized by making it higher than an one side side in the range whose near heights height is 3-20 micrometers on the other hand, and press workability.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the steel plates excellent in the image clarity used for an automobile, the shell plate of home electronics, etc., and press workability. Steel plates mean the tabular product painted and used here, for example, a stainless steel plate, an aluminum plate, a copper plate, etc. are included other than steel plates, such as hot rolled sheet steel, cold rolled sheet steel, and surface treated steel sheets (an electroplating steel plate, a hot-dipping steel plate, an alloying processing hot-dipping steel plate, a vacuum evaporationo plating steel plate, molten salt electrolysis plating steel plate, etc.).
[0002]
[Description of the Prior Art] Generally, although the steel plate used for the body of an automobile, the shell plate of home electronics, etc. is used as a product by performing press forming, with highly-precise-izing and complication of a product, the demand to steel plates is being upgraded and diversified more than before, and the demand about paint image clarity and press-forming nature is increasing especially recently. For example, although it is certainly improvable by thickening paint thickness in order to raise the image clarity of the product itself, there is a problem to which paint costs become high. Moreover, although paint and 4 times paint are performed 3 times in the present condition in order to secure paint image clarity, to omit the number of coats to 2 or 3 times for process saving and paint costs reduction is desired strongly. In order to meet such a demand, minute irregularity is prepared in a reduction roll using laser like JP,63-132701,A, steel plates are rolled out using the reduction roll, and obtaining the steel plate excellent in paint image clarity is known.
[0003]
[Problem(s) to be Solved by the Invention] In order to raise paint image clarity, the front face of a steel plate is flat, and it is so advantageous that it is close to a mirror plane. For this reason, various proposals are made towards making a front face fine. However, that it is easy to actualize a crack in a heat treatment process or a plating process in the production process of steel plates, if it only mirror-plane-izes, since a surface crack occurs at the time of piling after cutting of steel plates, or press working of sheet metal and it becomes surface discontinuity, various devices are proposed again. By the way, although press working of sheet metal will be the requisite in case a product is manufactured, there is a problem which grinding stone credit may be carried out in this case for the surface appearance improvement after processing, and for this reason looms after a grinding stone credit pattern's painting. Moreover, since steel plate roughness changes with press working of sheet metal, there is a problem on which image clarity deteriorates, so that workability becomes severe. For this reason, a steel plate which can maintain paint image clarity even with after [good] processing is desired strongly.
[0004] Moreover, recently, since press working of sheet metal of the components of a complicated configuration is carried out, it is desired for the sliding nature at the time of shaping to be good. Under high planar pressure, since a dice and a plating layer tend to agglutinate and frictional resistance increases, surface treated steel sheets, such as a galvanized steel sheet and an alloying processing hot-dip

zinc-coated carbon steel sheet, especially have the problem that the shaping fitness range is narrow that it is easy to carry out plate fracture at the time of shaping. This invention tends to offer the steel plates which improve the sliding property at the time of press forming, and can secure image clarity even with after [good] press working of sheet metal in order to respond to the quality technical problem required of an image clarity steel plate which was mentioned above exactly.

[0005]

[Means for Solving the Problem] In front flesh-side both sides of a steel plate, the magnitude of a scattered heights top face this invention 10-1000 micrometers, At 70% or more, 50-2200 micrometers and the rate of crevice area carry out [distance / between heights peaks] discrete distribution of the heights so that the roughness of a crevice may become less than [Ra0.8micrometer]. And it is in the range whose height of the heights top-most vertices which are scattered in a steel plate one side side is 2-12 micrometers, and the steel plate excellent in the paint image clarity characterized by making it higher than an one side side in the range whose near heights height is 3-20 micrometers on the other hand, and press workability is offered. That is, this invention is giving a roughness profile which is different on the front reverse side, and after press forming is characterized by securing good paint image clarity at the same time it improves the sliding nature at the time of press forming.

[0006] The gestalt of the roughness profile of this invention is explained to a detail below. constituting the roughness profile which consists of a flat crevice which occupies most steel plate front faces, and very small heights which are discretely scattered the optimal found out that it was certainly improvable importantly so that we maintained good paint image clarity before and after processing, and it might state below, as a result of examining many things about the conditions of the roughness profile for boiling press-forming nature markedly and improving. If it is not processed, it is satisfactory, but when it is processed, with the conventional technique, there is a problem on which paint image clarity deteriorates. In order to secure paint image clarity even with after [good] press working of sheet metal, it found out that the height of the heights of the other sides which become an inside side in the front flesh side of a steel plate at the time of press forming was improvable by making it higher than the heights height by the side of one side used as external surface. Furthermore, like recently, since severe press-forming nature was required, much more moldability improvement is desired, it analyzed about the structure on the optimal front face of a steel plate of improving these both, and this invention was reached.

[0007] Next, sequential explanation of the main point of this invention is given. Paint image clarity is related to the roughness and the rate of area of a steel plate crevice. Therefore, although it is desirable as roughness of a crevice that it is flat as much as possible, and close to a mirror plane, for manufacturing advantageously industrially, if it is 0.8 micrometers or less in Ra, paint image clarity can be secured enough, and it may be satisfied. Moreover, although the rate of area of a crevice is so advantageous to the improvement in paint image clarity that it is high, it is desirable for the rate of crevice area to secure in the range 70 to 96%. If the rate of crevice area is smaller than 70%, even if it will improve the roughness of a crevice, it becomes difficult to secure image clarity. Moreover, if conversely larger than 96%, although image clarity is good, since ****-proof and the sliding nature at the time of a press deteriorate, it is not desirable. On the other hand, even if it is smaller than 70%, since the paint image clarity after processing deteriorates even if it is larger than 96%, the above-mentioned range is the optimal [image clarity].

[0008] It is required for the heights height by the side of a field besides the steel plate with which the heights height of steel plate one side which sets magnitude of a heights crowning to 10-1000micrometerphi, and serves as external surface of shaping components, on the other hand, serves as an inside of 2-12 micrometers and shaping components about the gestalt of heights to be higher than an one side side in the range of 3-20 micrometers or less. As for these heights, naturally, it is desirable that you make it discretely distributed in the range of 30 - 4% of rates of area. Since there is no effectiveness which gives heights since it will be crushed without the ability resisting the planar pressure of a dice at the time of press working of sheet metal, if the magnitude of a heights top face is smaller than 10 micrometers, it is not desirable. On the other hand, if it is made larger than 1000 micrometers, since

sliding nature deteriorates since the contact surface moment with a dice increases at the time of press working of sheet metal, or paint image clarity deteriorates further, it is not desirable.
[0009] By the way, since paint image clarity was thought as important, the external surface side of a press product made the heights height by the side of steel plate one side into 2-12-micrometer range for giving the minimum heights of extent which can secure ****-proof. That is, in that a crack is attached to a steel plate front face in the production process of a steel plate since ****-proof will deteriorate if smaller than 2 micrometers, and a steel plate conveyance process, it is not desirable in order for a roll crack and an abrasion to occur and to loom after these defects' painting. Conversely, even if it makes it larger than 12 micrometers, when about [that these improvement effects are not seen] and paint thickness is not enough, heights will loom after paint and it is not desirable.
[0010] The reason for on the other hand making the heights height by the side of a field besides the steel plate which becomes the inside side of shaping components higher than an one side side in the 3-20-micrometer range is explained. On the other hand, paint image clarity is important for a side in order [of a steel plate] to control not a problem but degradation of image clarity according rather to the roughness change after reservation of the sliding nature at the time of shaping, and press working of sheet metal. That is, at the time of press forming, in a bead part or a blank holder part, in order to receive processing accompanied by sliding under high planar pressure, the frictional resistance on a dice and the front face of a steel plate increases, and there is a problem to which sliding nature deteriorates or a plating layer exfoliates in the case of a surface treated steel sheet. It is important to reduce the micro rate of contact surface area on a dice and the front face of a steel plate, in order to avoid this problem, and in order to secure sliding nature in the bottom condition of high pressure, it is desirable to secure the rate of heights area of a steel plate in 30 - 4% of range, and to set heights height to 20 micrometers or less by 3 micrometers or more.
[0011] That is, since the contact surface moment with a dice will increase if the rate of heights area becomes larger than 30%, the effectiveness of frictional resistance reduction is lost. On the other hand, if it becomes smaller than 4%, at the time of high pressure, planar pressure cannot be borne, but it will be crushed, and effectiveness will be lost. Moreover, since the frictional resistance reduction effectiveness is saturated upwards and paint image clarity may deteriorate even if it makes it higher than 20 micrometers preferably; since the effectiveness of reducing frictional resistance will be lost if heights height becomes lower than 3 micrometers, it is not desirable.
[0012] Next, the reason for on the other hand making near heights height higher than one side is explained. As a result of examining many things about the reason paint image clarity deteriorates after press working of sheet metal, it became clear that it was for the external waviness component of near roughness to float and appear in an one side side on the other hand by the draft of punch at the time of press working of sheet metal. As a result of working on this prevention policy, it became clear that after processing could maintain the paint image clarity by the side of one side good by on the other hand making near heights height higher than the heights height by the side of one side. As a result, the frictional resistance at the time of high planar pressure sliding is also held at lower order, and becomes coincidence with a desirable thing.
[0013] To a steel plate, various rollings, such as hot rolling, cold rolling, and temper rolling, are obtained, and, usually board thickness control, quality-of-the-material control, and configuration control are performed. For this reason, since the roughness profile with various rolls is imprinted by the steel plate front face, the external waviness component of the roughness of various wavelength exists. Removing this external waviness component has the problem by which various difficulties are accompanied upwards industrially and which cannot be solved by the approach cheap in cost.
[0014] That image clarity deteriorates by press working of sheet metal originates in roughness on the back being imprinted by the opposite side at the time of shaping. That is, when it is carried out under high pressure from a side on the other hand with the punch which has a smooth front face when press forming is carried out, on the other hand, a near external waviness component will be extruded at an one side side, the external waviness component of the roughness by the side of one side will increase, and paint image clarity will deteriorate. We found out that near heights were avoidable by the thing in

contact with punch made high on the other hand, as a result of examining many things about the solution approach of this problem. Since it has the effectiveness that these heights reduce the micro true contact surface moment with punch or a dice to coincidence, the frictional resistance in high planar pressure decreases, the sliding nature at the time of press forming is improved, and there is an advantageous point which the shaping fitness range expands.

[0015] thus -- on the other hand -- the roughness from a side -- a wave -- in order to control the imprint of a component, the arrangement spacing is also important in addition to the height of heights. Although what is necessary is just to arrange at spacing from which the rate of area of heights generally becomes 30 - 4%, spacing of the range of 50-2200 micrometers is desirable. Since heights spacing is too narrow in it being less than 50 micrometers, the effectiveness which controls the imprint of an external waviness component decreases. On the other hand, since the shaping load which one heights take charge of will become excessive if larger than 2200 micrometers, in the heights height of height range of 3-20 micrometers, it is crushed simply, and is ineffective.

[0016] In order to avoid this problem, the rate of heights area can be raised or it can consider making the magnitude of the top face of heights increase etc., but it is not effective in order for all to raise a sliding friction, or for there to be no effectiveness in imprint prevention of a wave or to make it deteriorate conversely. Thus, in this invention, it was the purposes to control that a near external waviness component is imprinted on the other hand at an one side side at the time of press forming, to maintain the paint image clarity by the side of one side good, and to decrease the friction sliding friction at the time of press forming to coincidence, and as a result of examining various roughness profiles fundamentally for this reason, this invention was reached.

[0017] it be the description of this invention that the press forming nature of a steel plate be boil markedly , and be raise by carry out optimal arrangement of the heights from which height differ discretely on the front reverse side of a steel plate in consideration of the magnitude , height , arrangement spacing , and the rate of area as mention above , and an imprint operation of the wave to one side by processing of a field besides a steel plate be mitigate also in processing order , and the outstanding paint image clarity can secure .

[0018] It is advantageous, in order to obtain the steel plate of this invention, for example, if a detailed irregularity pattern is given to a reduction roll using the micro lithography method and a steel plate is rolled out and obtained using this reduction roll. As the approach is shown in drawing 1 , after irradiating the light of specific wavelength in the roll surface which applied the resist material exposed on specific wavelength, making it expose and developing negatives, a roll surface is etched by chemical etching or gas phase etching, and a detailed concavo-convex pattern is established by removing the hardening resist section. Thus, the cross section of the obtained steel plate is shown in drawing 3 . In addition, in P in drawing, the distance between heights peaks and D show the magnitude of a heights crowning, and t shows heights height, respectively.

[0019]

[Example] As shown in drawing 1 , the detailed concavo-convex pattern was given to the temper rolling roll (finishing roughness Ra2.4micrometer) by the micro lithography method. Temper rolling was performed for the alloying processing hot-dip zinc-coated carbon steel sheet (0.8mm of board thickness) manufactured in usual continuation mold hot-dip-zincing Rhine at 1.0% of rolling reduction using the work roll. It is before and after processing about the obtained steel plate, and comparison investigation of paint image clarity and the sliding friction was conducted. In addition, each Ra of the crevice of a steel plate which manufactured in this way was in the range of about 0.55-0.70 micrometers. After taking a photograph of the size (D) of the top face of the heights on the front face of a steel plate, and the rate of area of a crevice and spacing (P) of heights with the optical microscope, image-analysis equipment estimated them quantitatively and they calculated the average. Moreover, from the cross-section profile curve measured with the sensing-pin type roughness meter, heights height calculated the average of the peak height corresponding to steel plate heights. In addition, heights height was found by the difference of elevation from the average height of the crest part of the profile curve of the crevice of the heights circumference to a heights peak location.

[0020] As a test method of paint image clarity, after performing paint of about 80 micrometers of thickness to the above-mentioned steel plate after temper rolling, the "specular gloss measuring method" of JIS-Z8741 estimated paint image clarity. As an evaluation test method of friction sliding nature, the square shape bead testing device of the L character tension shown in drawing 2 R> 2 was used, and it pressed down with the tension tester, and asked for the relation between a load and a tensile load. Here, comparative evaluation is carried out not by coefficient of friction but by the presser-foot load (Pc) of the limitation which plate fracture produces, and frictional resistance can judge that it is few and sliding nature is good, so that this value of Pc is large. As a test condition, one sample offering steel plate is used for every presser-foot load, and it is the slushing oil for the usual galvanized steel sheets (viscosity 6cst 40 degree C) at coverage as the board width of 17mm, sliding die length of 250mm, and 500mm a part for /and the lubricating oil in tension rate 1g/m2 The trial was presented after applying.
[0021] As the image clarity evaluation approach after processing, 750mm square shape punch performed deep drawing, and extruding was carried out with the punch shoulder radius of 100mm. In addition, the one side side of a steel plate was made into the evaluation side, and on the other hand, press working of sheet metal was carried out as a punch side, and in a part for the shoulder of the workpiece equivalent to the part in contact with punch, the side gave paint image clarity to the one side side which becomes the external surface side of a workpiece, and carried out comparative evaluation of the paint image clarity by the visual evaluation approach.
A visual score: (good) O - ** - x (**)
A test result is shown in Table 1. consequently, it is in ** that this invention boils markedly the steel plate manufactured by this invention in both sides of paint image clarity and sliding nature, and it is excellent since the example of a comparison of this invention and the paint image clarity before and behind processing are maintained by the high order and friction sliding nature is also maintained good.
[0022]
[Table 1]

表 1

	番号	凸部サイズと配置間隔(片面側/他面側)			凹部の平均面積率 (%)	塗装鮮映性 加工前 (%) 片面/他面	塗装外観 加工後 (片面側)	摺動性限界荷重 Pc/kgf
		凸部径 (Dμm)	凸部間隔 (Pμm)	凸部高さ (tμm)				
本発明	1	50/50	100/100	5/10	80/80	84/78	○	250
	2	100/100	300/170	3/5	90/72	88/68	○	210
	3	300/100	750/200	5/18	87/80	85/75	○	230
	4	15/70	60/140	3/5	95/80	95/80	○	200
	5	100/100	200/200	4/8	80/80	80/78	○	220
	6	150/400	300/1000	3/8	80/88	81/82	○	220
	7	100/150	240/300	13/18	86/80	81/75	○	240
	8	400/1000	800/2200	5/8	80/81	80/75	○	205
比較例	1	8/200	24/600	3/3	90/90	85/89	×	210
	2	100/100	200/200	15/17	80/80	77/79	△	230
	3	1100/1100	2300/2300	7/15	80/80	82/79	△	170
	4	100/100	120/120	4/7	45/45	45/42	×	180
	5	100/100	250/300	2/25	87/90	88/80	△	220

[0023]
[Effect of the Invention] The steel plate which has improved press-forming nature by reducing a sliding friction, and excelled [after / press forming] in paint image clarity is obtained at the same time it improves paint image clarity, when this invention limits the difference of elevation in the heights gestalt on the front face of a steel plate, distribution, and a front flesh side to a certain range.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] (a), (b), (c), and the (d) Fig. are an explanatory view showing an example of the concavo-convex grant processing process of this invention by the lithography method.
[Drawing 2] The mimetic diagram showing the testing device which measures the sliding friction of a steel plate.
[Drawing 3] The cross section of the steel plate obtained by this invention.
[Description of Notations]
1 Hopper
2 Liquefied Sensitization Resin
3 Ayr
4 Sensitization Resin Feeder
5 Photopolymer Layer
6 Laser Oscillation Machine
7 Laser
8 Slit
9 Chopper
10 Sensitization Hard Spot
11 Sprayer
12 Resolvent
13 Outcrop
14 Heights Bead
15 Steel Plate for Trial
16 Receptacle Mold Dice

[Translation done.]

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		Ｃ　7128－4Ｅ		

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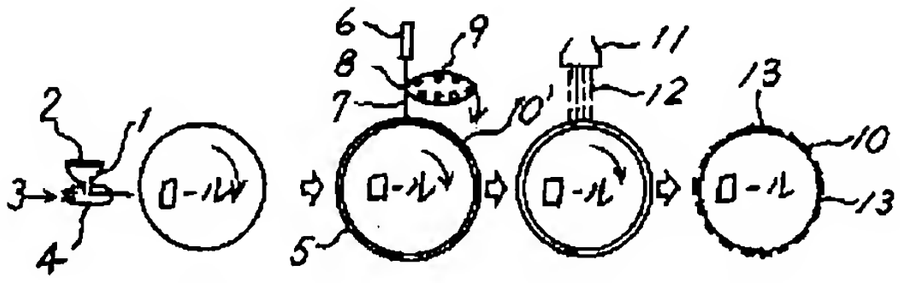
(54)【発明の名称】　塗装鮮映性とプレス加工性に優れた鋼板

(57)【要約】

【目的】　本発明はプレス加工を行なった後でも塗装鮮映性の優れた鋼板を提供する。

【構成】　鋼板の表裏両面において、散在する凸部頂面の大きさが１０～１０００μｍ、凸部ピーク間距離５０～２２００μｍ、凹部の粗度Ｒａが０．８μｍ以下で凹部の平均面積率が７０％以上となるように凸部を離散分散させ、かつ鋼板片面側に散在する凸部頂点の高さが２～１２μｍの範囲にあり、他面側の凸部高さが３～２０μｍの範囲で片面側より高くすることを特徴とする塗装鮮映性とプレス加工性に優れた鋼板。



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【特許請求の範囲】

【請求項１】　鋼板の表裏両面において、散在する凸部頂面の大きさが１０～１０００μm、凸部ピーク間距離が５０～２２００μm、凹部の粗度Ｒａが０．８μm以下で凹部の平均面積率が７０%以上となるように凸部を離散分散させ、かつ鋼板片面側に散在する凸部頂点の高さが２～１２μmの範囲にあり、他面側の凸部高さが３～２０μmの範囲で片面側より高くすることを特徴とする塗装鮮映性とプレス加工性に優れた鋼板。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】本発明は自動車や家電製品の外板等に使用する鮮映性とプレス加工性に優れた鋼板類に関するものである。ここで鋼板類とは、塗装して使用する板状の製品を意味し、例えば熱延鋼板、冷延鋼板、表面処理鋼板（電気めっき鋼板、溶融めっき鋼板、合金化処理溶融めっき鋼板、蒸着めっき鋼板、溶融塩電解めっき鋼板など）などの鋼板の他に、例えばステンレス鋼板、アルミニウム板、銅板なども含むものである。

【０００２】

【従来の技術】一般に、自動車のボディーや家電製品の外板等に使用する鋼板はプレス成形を施すことにより製品として使用されるが、製品の高精度化と複雑化に伴い、鋼板類に対する要求が従来以上に高級化、多様化しつつあり、中でも最近は塗装鮮映性とプレス成形性に関する要求が高まっている。例えば、製品自体の鮮映性を向上させるには、塗装膜厚を厚くすることで確実に改善できるが、塗装費用が高くなる問題がある。また現状では塗装鮮映性を確保するため、３回塗装や４回塗装が施されているが、省工程と塗装費用削減のため塗装回数を２または３回に省略することが強く望まれている。こうした要求に応えるために例えば、特開昭６３－１３２７０１号公報の如くレーザーを用いて圧延ロールに微小な凹凸を設け、その圧延ロールを用いて鋼板類を圧延し、塗装鮮映性に優れた鋼板を得ることが知られている。

【０００３】

【発明が解決しようとする課題】塗装鮮映性を向上させるには、鋼板の表面が平坦で鏡面に近いほど有利である。このため表面を細かくする方向で種々の提案がなされている。ただし単に鏡面化すると鋼板類の製造工程において、熱処理工程やめっき工程において疵が顕在化し易くまた、鋼板類の切断後のパイリングやプレス加工時に表面疵が発生し、表面欠陥となるため種々の工夫が提案されている。ところで製品を製造する際にはプレス加工が前提となるが、この場合に加工後表面外観改善のため砥石掛けされることがあり、このため砥石掛け模様が塗装後に浮き出る問題がある。またプレス加工により鋼板粗度が変化するため、加工度が厳しくなるほど鮮映性が劣化する問題がある。このため加工後も良好な塗装鮮映性を維持できる鋼板が強く望まれている。

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【０００４】また最近では複雑な形状の部品をプレス加工することから、成形時の摺動性が良好であることが望まれている。とりわけ亜鉛めっき鋼板や合金化処理溶融亜鉛めっき鋼板などの表面処理鋼板は、高面圧下ではダイスとめっき層が凝着し易く、摩擦抵抗が増大するため、成形時に板破断し易くかつ成形適性範囲が狭い問題がある。本発明は、上述したような鮮映性鋼板に要求される品質課題に的確に応えるため、プレス成形時の摺動特性を改善し、かつプレス加工後も良好な鮮映性を確保できる鋼板類を提供しようとするものである。

【０００５】

【課題を解決するための手段】本発明は、鋼板の表裏両面において、散在する凸部頂面の大きさが１０～１０００μm、凸部ピーク間距離が５０～２２００μm、凹部面積率が７０%以上で凹部の粗度がＲａ０．８μm以下となるように凸部を離散分散させ、かつ鋼板片面側に散在する凸部頂点の高さが２～１２μmの範囲にあり、他面側の凸部高さが３～２０μmの範囲で片面側より高くすることを特徴とする塗装鮮映性とプレス加工性に優れた鋼板を提供するものである。すなわち、本発明は表裏で異なる粗度プロフィルを付与することで、プレス成形時の摺動性を改善すると同時に、プレス成形後も良好な塗装鮮映性を確保することを特徴とするものである。

【０００６】本発明の粗度プロフィルの形態に関して次に詳細に説明する。我々は加工前後においても良好な塗装鮮映性を維持し、かつプレス成形性を格段に改善するための粗度プロフィルの条件について種々検討した結果、次に述べるように、鋼板表面の大部分を占有する平坦な凹部と、離散的に散在する微少な凸部からなる粗度プロフィルを最適に構成することが重要であり、かつ確実に改善できることを見いだした。加工しなければ問題はないが、加工すると従来技術では塗装鮮映性が劣化する問題がある。プレス加工後も良好な塗装鮮映性を確保するためには、鋼板の表裏においてプレス成形時に内面側となる他面の凸部の高さを、外面となる片面側の凸部高さより高くすることで改善できることを見いだした。更に最近のように、過酷なプレス成形性が要求されるため、一層の成形性改善が望まれており、この両者を改善する最適な鋼板表面の構造について解析し本発明に到達した。

【０００７】次に本発明の要点を順次説明する。塗装鮮映性は鋼板凹部の粗度と面積率に関係する。したがって、凹部の粗度としては極力平坦で鏡面に近いことが望ましいが、工業的に有利に製造するにはＲａで０．８μm以下であれば塗装鮮映性を充分確保でき満足しうるものである。また凹部の面積率は高いほど塗装鮮映性向上に有利であるが、凹部面積率が７０～９６%範囲で確保することが望ましい。凹部面積率が７０%より小さいと凹部の粗度を改善しても、鮮映性を確保することが困難となる。また逆に９６%より大きいと鮮映性は良好であ

るが、耐疵性やプレス時の摺動性が劣化するため好ましくない。一方、加工後の塗装鮮映性は７０％より小さくても、９６％より大きくても劣化するため上記範囲が最適である。

【０００８】一方、凸部の形態に関しては、凸部頂部の大きさは１０～１０００μｍφとし、成形部品の外面となる鋼板片側の凸部高さが２～１２μｍ、成形部品の内面となる鋼板他面側の凸部高さが３～２０μｍ以下の範囲において片面側より高いことが必要である。当然この凸部は面積率３０～４％の範囲で離散的に分布させることが望ましい。凸部頂面の大きさが１０μｍより小さいと、プレス加工時にダイスの面圧に抵抗できずに潰されるため、凸部を付与する効果がないため好ましくない。一方、１０００μｍより大きくすると、プレス加工時にダイスとの接触面積率が増大するため摺動性が劣化したり、さらには塗装鮮映性が劣化するため好ましくない。

【０００９】ところで鋼板片面側の凸部高さを２～１２μｍ範囲としたのは、プレス製品の外面側は塗装鮮映性が重視されるため、耐疵性を確保できる程度の最小限凸部を付与するためである。すなわち、２μｍより小さいと耐疵性が劣化するため、鋼板の製造工程において鋼板表面に疵が付くこと、また鋼板搬送工程において、ロール疵や擦り疵が発生し、これら欠陥が塗装後浮き出るため好ましくない。逆に１２μｍより大きくしてもこれら改善効果が見られないばかりか、塗装膜厚が充分でない場合には塗装後に凸部が浮き出ることになり好ましくない。

【００１０】一方、成形部品の内面側となる鋼板他面側の凸部高さを３～２０μｍ範囲で片面側より高くする理由について述べる。鋼板の他面側は塗装鮮映性は問題でなく、むしろ成形時の摺動性の確保とプレス加工後の粗度変化による鮮映性の劣化を抑制するために重要である。すなわち、プレス成形時にビード部分やしわ押さえ部分では、高面圧下で摺動を伴う加工を受けるため、ダイスと鋼板表面との摩擦抵抗が増大し、摺動性が劣化したり、表面処理鋼板の場合にはめっき層が剥離したりする問題がある。この問題を回避するには、ダイスと鋼板表面とのミクロ的な接触表面積率を低減することが重要で、高圧下状態において摺動性を確保するには、鋼板の凸部面積率を３０～４％の範囲に確保しかつ、凸部高さを３μｍ以上で２０μｍ以下とすることが望ましい。

【００１１】すなわち、凸部面積率が３０％より大きくなるとダイスとの接触面積率が増大するため摩擦抵抗低減の効果がなくなる。一方４％より小さくなると高圧時に面圧に耐えられず潰れることになり効果がなくなる。また凸部高さが３μｍより低くなると摩擦抵抗を低減する効果がなくなるため好ましくなく、また２０μｍより高くしても摩擦抵抗低減効果が飽和する上に、塗装鮮映性が劣化することがあるため好ましくない。

【００１２】次に片面よりも他面側の凸部高さを高くする理由について説明する。プレス加工後に塗装鮮映性が劣化する理由について種々検討した結果、プレス加工時にポンチの圧下により、他面側の粗度のうねり成分が片面側に浮きでるためであることが判明した。この防止方策を検討した結果、他面側の凸部高さを片面側の凸部高さより高くすることで加工後も片面側の塗装鮮映性を良好に維持できることが判明した。同時にこの結果、高面圧摺動時の摩擦抵抗も低位に保持され、望ましいものとなる。

【００１３】鋼板には熱間圧延、冷間圧延、調質圧延など種々の圧延を得て板厚制御、材質制御、形状制御が行われるのが普通である。このため種々のロールによる粗度プロフィルが鋼板表面に転写されているため、種々の波長の粗度のうねり成分が存在する。このうねり成分を除去することは工業的に種々の困難が伴う上にコスト的に安価な方法で改善できない問題がある。

【００１４】プレス加工により鮮映性が劣化するのは、成形時に裏面の粗度が反対面に転写されることに起因する。すなわち、プレス成形すると平滑な表面を有するポンチにより他面側から高圧下されると、他面側のうねり成分が片面側に押し出されることになり、片面側の粗度のうねり成分が増大し、塗装鮮映性が劣化することになる。我々はこの問題の解決方法について種々検討した結果、ポンチと接触する他面側の凸部を高くすることで回避できることを見いだした。同時にこの凸部がポンチやダイスとのミクロ的な真実接触面積率を低下させる効果を有するため、高面圧での摩擦抵抗が減少し、プレス成形時の摺動性を改善し、成形適性範囲が拡大する有利な点がある。

【００１５】このように他面側からの粗度うねり成分の転写を抑制するには、凸部の高さ以外にその配置間隔も重要である。一般的には凸部の面積率が３０～４％となるような間隔で配置すればよいが、５０～２２００μｍの範囲の間隔が好ましい。５０μｍ未満であると凸部間隔が狭すぎるため、うねり成分の転写を抑制する効果が減少する。一方、２２００μｍより大きいと１個の凸部の受け持つ成形荷重が過大となるため、高さ３～２０μｍ範囲の凸部高さでは簡単に潰されて効果がない。

【００１６】この問題を回避するために、凸部面積率を高めたり、凸部の頂面の大きさを増加させることなどが考えられるが、いずれも摺動抵抗を高めたり、うねりの転写防止に効果がないか、または逆に劣化させたりするため有効ではない。このように本発明では、プレス成形時に他面側のうねり成分が片面側に転写されるのを抑制すること、片面側の塗装鮮映性を良好に維持すること、同時にプレス成形時の摩擦摺動抵抗を減少させることが目的であり、このため種々の粗度プロフィルを基礎的に検討した結果、本発明に到達した。

【００１７】上述したように鋼板の表裏で高さの異なる凸部をその大きさ、高さ、配置間隔、面積率を考慮して

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離散的に最適配置することで、鋼板のプレス成形性を格段に向上させ、かつ加工前後においても鋼板他面の加工による片面へのうねりの転写作用を軽減し、優れた塗装鮮映性を確保できることが本発明の特徴である。

【００１８】本発明の鋼板を得るには、例えばマイクロリソグラフィー法を用いて圧延ロールに微細凹凸模様をつけ、該圧延ロールを用いて鋼板を圧延して得ると有利である。その方法を図１に示す如く、特定の波長で感光するレジスト材を塗布したロール表面に特定波長の光を照射し感光させ、現像した後、化学的エッチングもしくは気相エッチングによってロール表面をエッチングし、硬化レジスト部を除去することによって微細な凹凸模様を設けるようにするものである。このようにして得られた鋼板の断面模式図を図３に示す。なお、図中のＰは凸部ピーク間距離、Ｄは凸部頂部の大きさ、ｔは凸部高さをそれぞれ示す。

【００１９】

【実施例】図１に示すように、調質圧延ロール（仕上げ粗度Ｒａ２．４μｍ）にマイクロリソグラフィー法により微細な凹凸模様をつけた。そのワークロールを用いて、通常の連続型溶融亜鉛めっきラインで製造した合金化処理溶融亜鉛めっき鋼板（板厚０．８ｍｍ）を圧下率１．０％で調質圧延を行った。得られた鋼板について加工前後で塗装鮮映性、摺動抵抗を比較調査した。なお、こうして製造した鋼板の凹部のＲａはいずれも約０．５５～０．７０μｍの範囲にあった。鋼板表面の凸部の頂面のサイズ（Ｄ）や凹部の面積率および凸部の間隔（Ｐ）は、光学顕微鏡により写真撮影してから、画像解析装置により定量的に評価しその平均値を求めた。また凸部高さは触針式粗度計により測定した断面プロフィル曲線から、鋼板凸部に対応したピーク高さの平均値を求めた。なお凸部高さは、凸部周辺の凹部のプロフィル曲線の山部分の平均高さから凸部ピーク位置までの高低差で求めた。

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【００２０】塗装鮮映性の試験方法としては、調質圧延後の上記鋼板に膜厚約８０μｍの塗装を施した後、ＪＩＳ－Ｚ８７４１の「鏡面光沢度測定法」により塗装鮮映性を評価した。摩擦摺動性の評価試験方法としては、図２に示すＬ字引張りの角型ビード試験装置を使用し、引張り試験機により押さえ荷重と引張り荷重の関係を求めた。ここでは摩擦係数でなく、板破断が生ずる限界の押さえ荷重（Ｐｃ）で比較評価し、このＰｃの値が大きいほど摩擦抵抗が少なく摺動性が良好と判断できる。試験条件としては、各押さえ荷重毎に１本の供試鋼板を使用し、その板巾１７ｍｍ、摺動長さ２５０ｍｍ、引張り速度５００ｍｍ／分、潤滑油として通常の亜鉛めっき鋼板用の防錆油（粘度６ｃｓｔ　４０℃）を塗布量で１ｇ／m^2 塗布してから試験に供した。

【００２１】加工後の鮮映性評価方法としては、７５０ｍｍ角型ポンチで深絞り加工を行い、ポンチ肩半径１００ｍｍにより押し出し加工した。なお、鋼板の片面側を評価面とし、他面側がポンチ側としてプレス加工し、ポンチと接触する部分に相当する加工品の肩部分において、加工品の外面側となる片面側に塗装鮮映性を施し、塗装鮮映性を目視評価方法により比較評価した。

目視評点：（良）○　－　△　－　×（劣）

試験結果を表１に示す。この結果、本発明により製造された鋼板は、本発明の比較例および加工前後における塗装鮮映性が高位に維持されておりかつ、摩擦摺動性も良好に維持されていることから、本発明が塗装鮮映性と摺動性の両面において格段に優れていることが明かである。

【００２２】

【表１】

表 1

	番号	凸部サイズと配置間隔(片面側／他面側) 凸部径 (Dμm)	凸部間隔 (Pμm)	凸部高さ (tμm)	凹部の平均面積率 (%)	塗装鮮映性 加工前 (%) 片面／他面	塗装外観 加工後 (片面側)	摺動性限界荷重 Pc/kgf
本発明	1	50/50	100/100	5/10	80/80	84/78	○	250
	2	100/100	300/170	3/5	90/72	88/68	○	210
	3	300/100	750/200	5/18	87/80	85/75	○	230
	4	15/70	60/140	3/5	95/80	95/80	○	200
	5	100/100	200/200	4/8	80/80	80/78	○	220
	6	150/400	300/1000	3/8	80/88	81/82	○	220
	7	100/150	240/300	13/18	86/80	81/75	○	240
	8	400/1000	800/2200	5/8	80/81	80/75	○	205
比較例	1	8/200	24/600	3/3	90/90	85/89	×	210
	2	100/100	200/200	15/17	80/80	77/79	△	230
	3	1100/1100	2300/2300	7/15	80/80	82/79	△	170
	4	100/100	120/120	4/7	45/45	45/42	×	180
	5	100/100	250/300	2/25	87/90	88/80	△	220

【００２３】

【発明の効果】本発明は鋼板表面の凸部形態と分布および表裏での高低差をある範囲に限定することにより、塗装鮮映性を改善すると同時に、摺動抵抗を低減することでプレス成形性を改善し、かつプレス成形後も塗装鮮映性に優れた鋼板が得られるものである。

【図面の簡単な説明】

【図１】（ａ）、（ｂ）、（ｃ）および（ｄ）図はリソグラフィー法による本発明の凹凸付与加工工程の一例を示す説明図。

【図２】鋼板の摺動抵抗を測定する試験装置を示す模式図。

【図３】本発明により得られた鋼板の断面模式図。

【符号の説明】

１　ホッパー

＊２　液状感光樹脂

３　エアー

４　感光樹脂供給器

５　感光性樹脂層

６　レーザー発振器

７　レーザー

８　スリット

９　チョッパー

１０　感光硬化部

１１　噴霧器

１２　溶解剤

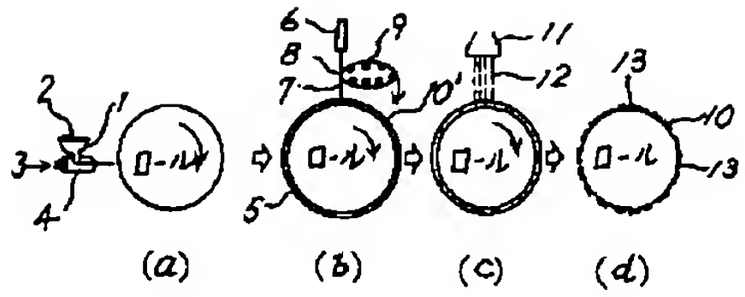
１３　露出部

１４　凸部ビード

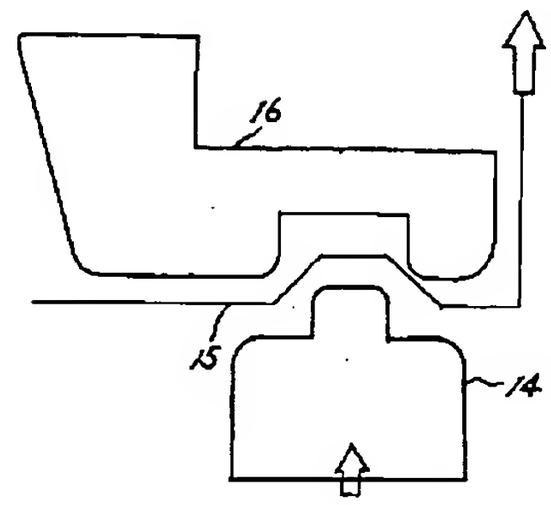
１５　試験用鋼板

１６　受け型ダイス

【図1】



【図2】



【図3】